ICAR **improves** over ERA-Interim but generates **unrealistic clouds** and **precipitation** at low model top settings

Precipitation downscaling in complex topography with ICAR evaluated with a weather-pattern based approach

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INTRO

- Local impact studies require detailed atmospheric fields, particularly in complex topography. In general, global models are too coarse.
- Climate downscaling closes the gap between global and local scale.
- In complex topography dynamic downscaling is usually computationally expensive and measurements required to calibrate statistical downscaling methods are often not available.
- These two drawbacks are addressed by the Intermediate Complexity Atmospheric Research (ICAR) model. It is based in physics (linear mountain wave theory), does not rely on measurements, and is computationally cheaper than dynamic downscaling.

METHODS

1. ICAR was used to downscale precipitation to 4x4 km² fields for the Southern Alps on the South Island of New Zealand and forced with ERA-Interim.
2. Simulated and measured daily precipitation at alpine sites was grouped by synoptic weather pattern and evaluated with an MSE based skill score.
3. Cross-sections of a high precipitation event during cross-alpine flow were investigated.

RESULTS

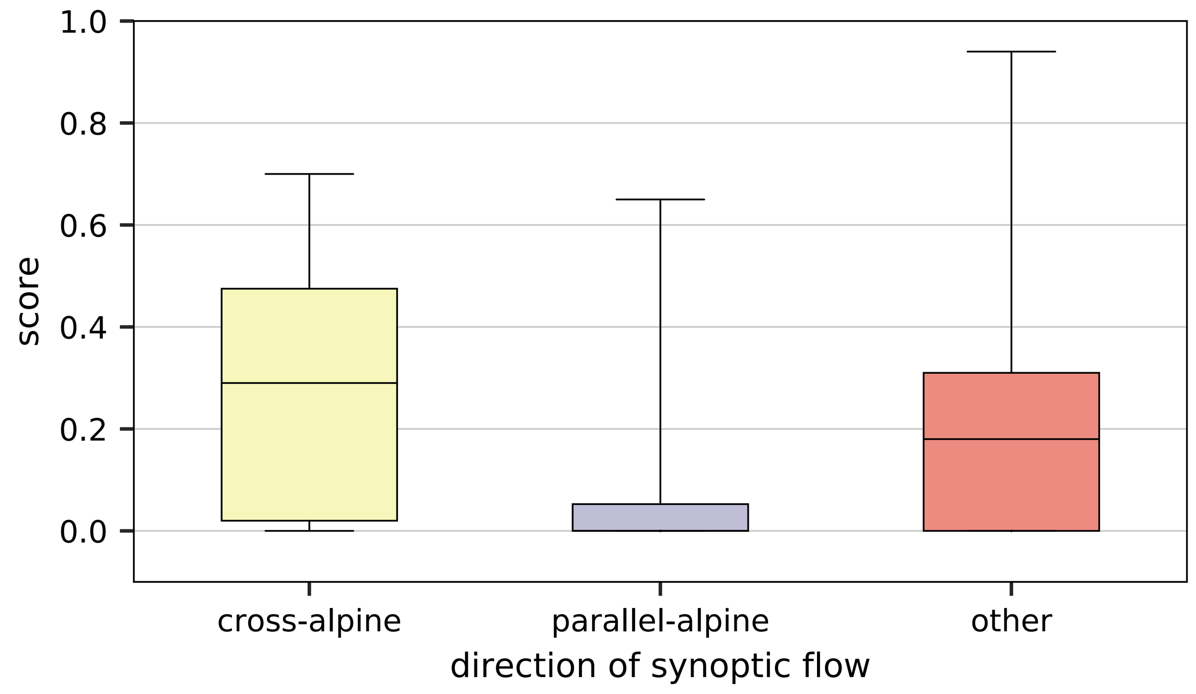

Figure 1. Performance of ICAR in dependence of the direction of the synoptic flow relative to the Alpine range.

DISCUSSION

ICAR generally improves over the global model and performs best for cross-alpine flow. Detailed analysis shows a potentially unrealistic accumulation of water and ice in the topmost vertical layers contributing to the simulated precipitation. This is very likely an artifact of the zero gradient boundary condition applied at the top. While higher model top settings improve realism, they increase computational cost.

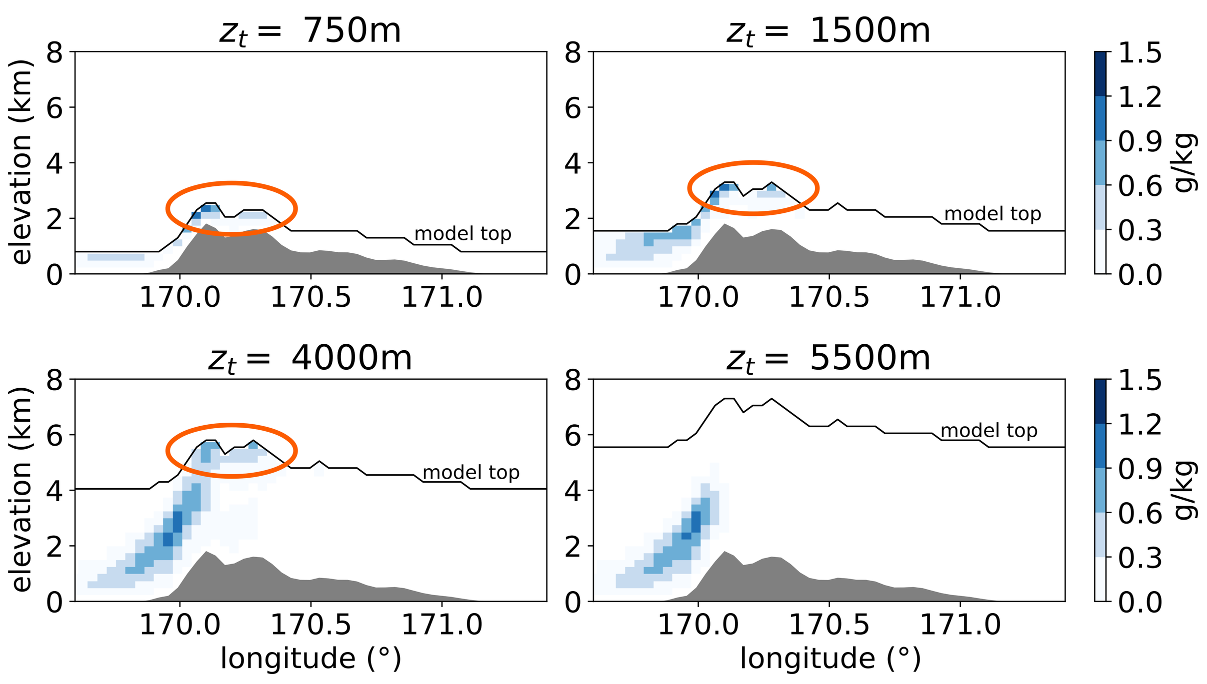

Figure 2. Distribution of cloud water in dependence of the choice of the model top elevation. Red circles indicate potentially unrealistic concentrations due to numerical artifacts.

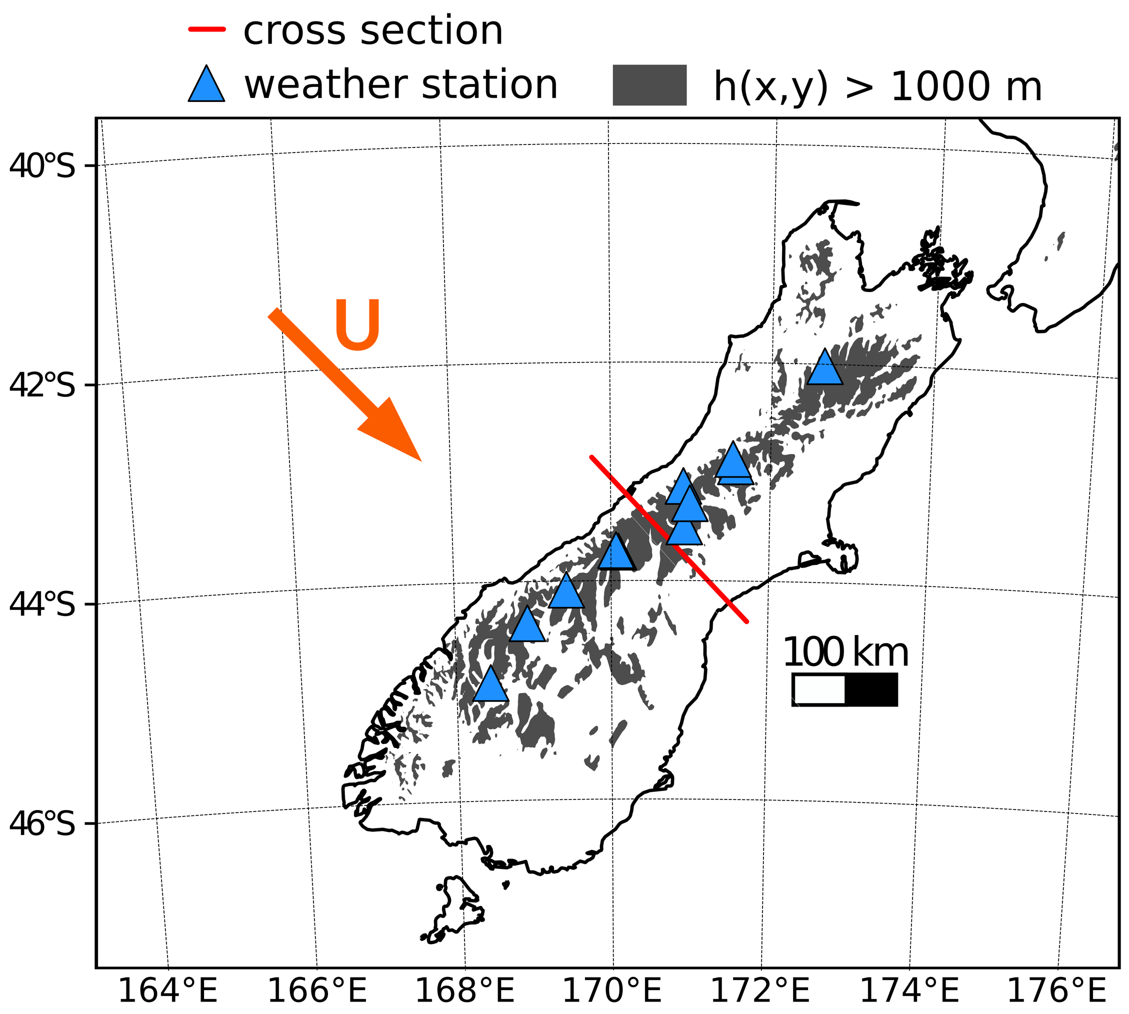

Figure 3. The South Island of New Zealand study domain.

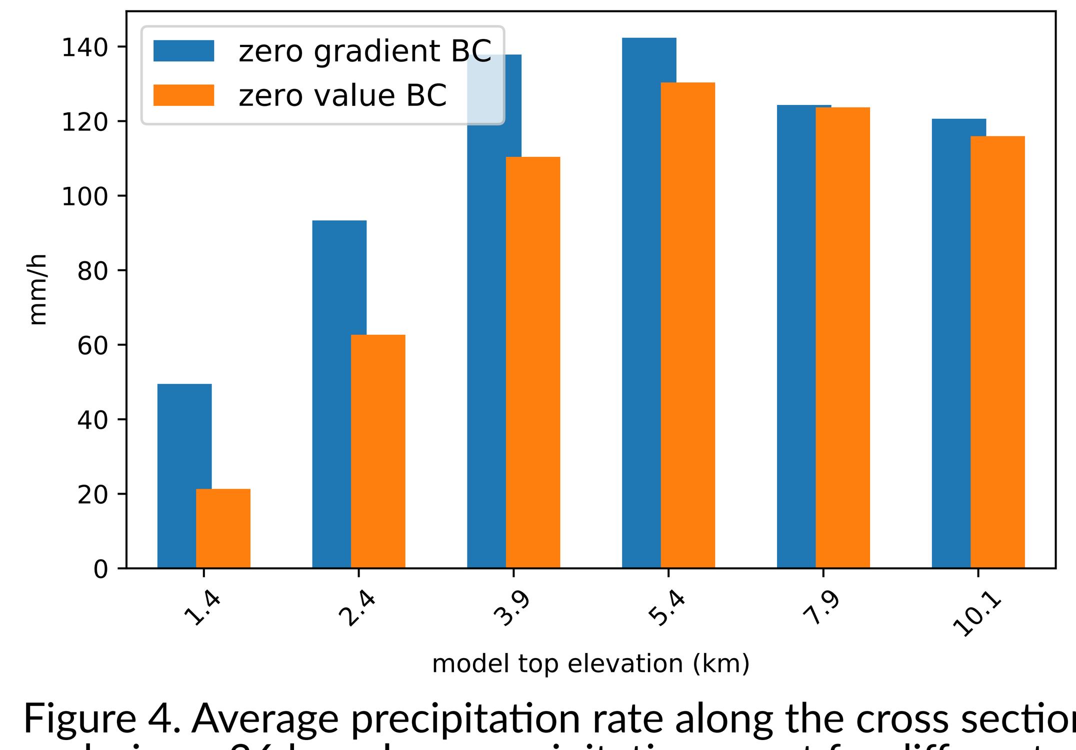

Figure 4. Average precipitation rate along the cross section during a 36 hour long precipitation event for different model top elevations and advection boundary conditions applied at the model top.

Reference
Horak et al., *Assessing the added value of the Intermediate Complexity Atmospheric Research (ICAR) model for precipitation in complex topography*, Hydrol. Earth Syst. Sci., 23, 2715–2734, https://doi.org/10.5194/hess-23-2715-2019, 2019.

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